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Enhancing Mathematics Learning Outcomes through Realistic Mathematics Education: Evidence from Classroom Implementation

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ABSTRACT

Purpose of the study: The aim of this study was to determine whether or not the Realistic Mathematics Education approach had an influence on students' mathematics learning outcomes.

Methodology: This study is a quasi-experimental study using a nonequivalent control group design consisting of 38 students in the experimental class and 35 students in the control class with a purposive sampling technique. The data collection technique used was a pretest and posttest.

Main Findings: The student learning outcomes test after being given treatment was analyzed using descriptive statistical analysis and inferential statistical analysis. The results showed a difference between the mathematics learning outcomes of students in the experimental class and students in the control class with $t_{count} > t_{table}$ ($t_{count} = 1.91$; $t_{table} = 1.666$). Based on this, it can be concluded that there is an influence of the Realistic Mathematics Education approach on student learning outcomes.

Novelty/Originality of this study: This study provides empirical evidence on the effectiveness of the Realistic Mathematics Education approach through a quasi-experimental, non-equivalent control group design at the classroom level. This study expands existing knowledge by demonstrating measurable differences in learning outcomes using pre-test and post-test analyses, thus strengthening the practical evidence base for implementing Realistic Mathematics Education in real-world learning environments.

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1. INTRODUCTION

Mathematics education plays a crucial role in developing students' logical, critical, and systematic thinking skills [1], [2]. Mathematics serves not only as a calculation tool but also as a means of understanding and solving problems in everyday life [3], [4]. Therefore, mathematics learning needs to be designed to be meaningful and relevant to students' real-life experiences. Learning that is not contextualized often causes students to struggle to grasp mathematical concepts [5], [6]. This condition impacts students' mathematics learning outcomes.

Mathematics learning outcomes are an important indicator in assessing the success of the learning process [7], [8]. Low learning outcomes indicate problems with the learning strategies implemented in the classroom [9], [10]. Many students still view mathematics as an abstract and difficult subject to understand. This perception can reduce students' motivation to learn and active participation in learning. Therefore, a learning approach is needed that connects mathematical concepts to real-life situations [11], [12].

The Realistic Mathematics Education approach emphasizes mathematics learning that begins with contextual problems and students' real-life experiences [13], [14]. This approach encourages students to construct their own understanding of mathematical concepts through exploration and discussion [15], [16]. By using real-life situations as a starting point for learning, students are expected to develop a deeper understanding of mathematical concepts [17], [18]. Learning becomes more meaningful because students can see the connection between mathematics and everyday life. This has the potential to increase student engagement in the learning process.

The implementation of the Realistic Mathematics Education approach also provides students with opportunities to develop critical thinking and problem-solving skills [19], [20]. Students not only receive information from the teacher but also actively construct knowledge through learning activities [21], [22]. The teacher acts as a facilitator, guiding students in discovering mathematical concepts. Interactions between students and teachers become more intensive and meaningful [23], [24]. This is expected to create a more active and enjoyable learning environment.

Various previous studies have shown that a contextual learning approach can improve students' mathematics learning outcomes [25], [26]. However, the application of the Realistic Mathematics Education approach still requires further study in the classroom context [27], [28]. Each learning environment has different characteristics, which can lead to varying research results [29], [30]. Therefore, research is needed to empirically test the effects of this approach. Quasi-experimental research can be used to compare learning outcomes between classes using this approach and classes using conventional learning.

The novelty of this research lies in presenting empirical evidence regarding the effectiveness of the Realistic Mathematics Education approach through a quasi-experimental design with a non-equivalent control group in a real classroom context. This study not only measures improvements in learning outcomes through a comparison of pre- and post-tests but also confirms statistical differences in learning outcomes between the experimental and control classes. This approach strengthens previous findings by providing quantitative data relevant to actual learning practices. Thus, this research contributes to enriching the study of the implementation of Realistic Mathematics Education in mathematics education. These findings provide a more contextual empirical basis for the application of a reality-based learning approach.

The urgency of this research is based on the persistently low mathematics learning outcomes of students caused by learning that tends to be abstract and lacking contextualization. This situation demands a learning approach that connects mathematical concepts to students' real-life experiences to make learning more meaningful. Realistic Mathematics Education is considered a relevant approach to address this issue, but its implementation still requires strengthening empirical evidence. This research is important because it illustrates the effectiveness of this approach in improving students' mathematics learning outcomes. The results are expected to inform teachers and policymakers' considerations in selecting more effective learning strategies.

Based on this description, this study aims to determine the effect of the Realistic Mathematics Education approach on students' mathematics learning outcomes. This research is expected to provide alternative, more effective learning approaches for mathematics teachers. Furthermore, the results can serve as a reference for curriculum developers in improving the quality of mathematics learning. The research findings can also enrich scientific studies in the field of mathematics education. With the right approach, mathematics learning is expected to become more meaningful and improve student learning outcomes.

2. RESEARCH METHOD

2.1. Research Forms

Experimental research is a research method used to determine the effect of a treatment on another variable under controlled conditions [31], [32]. In this study, two sample groups are compared based on the treatment administered to determine any differences in outcomes. This approach allows researchers to systematically identify the effects of the treatment. Comparisons between groups form the basis for drawing conclusions about the treatment's effectiveness. Therefore, experimental research focuses on cause-and-effect relationships.

The type of research used is quasi-experimental research, which is widely applied in education. This type of research is a form of experimental research that does not allow for complete control of all variables involved. Quasi-experiments aim to determine the effect of a treatment on the characteristics of the object being studied. Although not all variables can be manipulated or strictly controlled, this research still provides insight into the effects of the treatment. Therefore, quasi-experiments are used to approximate actual experimental conditions in real-life learning situations.

2.2. Research Design

The research design used in this study is a Nonequivalent Control Group Design. This design can be seen in the following table:

Table 1. Research Design

O_1	X	O_2
....		
O_3		O_4

O_1 shows the results of the initial test in the experimental class, while O_3 shows the results of the initial test in the control class. The treatment given to the experimental class is the application of a realistic mathematics learning approach, symbolized by X. O_2 is the final test result in the experimental class, while O_4 is the final test result in the control class. This study involved two classes, namely the experimental class and the control class, which were used to compare students' mathematics learning outcomes through the application of the Realistic Mathematics Education approach and conventional learning.

2.3. Research Population and Sample

A research population is the entire object or subject of interest to the researcher within a specific scope and timeframe, possessing predetermined characteristics to be studied and conclusions drawn from [33], [34]. Therefore, a population encompasses all data relevant to the research objectives. Based on this definition, the population in this study was all seventh-grade students at Pekanbaru State Junior High School 9. The population consisted of 342 students spread across nine classes. This population was selected because it was considered representative of the characteristics that align with the research objectives.

The sample is a subset of the population that shares similar characteristics and is chosen to represent the population as a whole. The sampling technique used in this study was purposive sampling, with specific considerations. This technique was chosen because there are three teachers teaching seventh grade, so the researcher chose classes taught by the same teacher: classes VII 1, VII 2, and VII 3. This selection aimed to minimize differences in treatment caused by differences in teacher teaching styles.

The next stage was the selection of research classes using a random sampling technique. The random sampling process was conducted by drawing lots using paper ballots to determine which classes would serve as the research samples. The results of the drawing showed that classes VII 1 and VII 3 were selected as the research samples. Class VII 1, with 35 students, was designated as the control class, while class VII 3, with 38 students, was designated as the experimental class. This selection was made to ensure objectivity in determining the control and experimental classes.

2.4. Research Procedures

The research procedure was carried out through several stages, namely the preparation stage and the implementation stage [35], [36]. In the preparation stage, the researcher first determined the experimental and control classes that would be used in the study. Next, the researcher determined the research schedule at Pekanbaru 9th State Junior High School and the learning materials to be used. The researcher also developed learning tools, including a syllabus, lesson plan, assessment system, teaching materials, and student worksheets. All of these tools were aligned with the established research objectives and design.

The implementation stage of the learning process was carried out in the experimental and control classes with different treatments. In the experimental class, learning began with introductory activities that included greetings, checking attendance, conveying learning objectives, providing motivation, linking the material to prior knowledge, and explaining the learning approach to be used [37], [38]. These activities aimed to prepare students mentally and academically before entering the main activities. The teacher also emphasized the benefits of the material in everyday life to make learning more meaningful.

The core activities in the experimental class were implemented using the Realistic Mathematics Education approach. The first stage began with understanding contextual problems, where students were presented with real-life problems to observe and understand. The teacher explains the material using appropriate media and encourages students to actively ask questions and engage in discussion. At this stage, the teacher acts as a mediator, helping students connect the problem to the mathematical concepts being studied.

The next stage involves solving contextual problems through group work. The teacher organizes students into study groups and distributes worksheets relevant to the material [39], [40]. Students actively develop their understanding and problem-solving models based on their own thinking. The teacher guides and facilitates each group so that the models developed by the students align with formal mathematical concepts. This process allows for the emergence of various problem-solving strategies.

The next stage involves comparing and discussing answers. Students process and associate the information obtained to compile the results of their group discussions. Each group presents their work to the class. The teacher manages the class discussion to foster interaction between students, between groups, and between students and the teacher. This discussion aims to enrich students' understanding of the concepts learned.

The learning activities in the experimental class conclude with a conclusion. The teacher invites students to reflect on the learning process and compile a summary of the material together. Next, the teacher conducts an evaluation to determine students' understanding of the material learned. The teacher also provides awards as a token of appreciation for students' efforts and work, both individually and in groups. The activity concludes with a presentation of the material to be covered in the next meeting. In the control class, learning began with introductory activities such as greetings, class conditioning, attendance checks, presentation of learning objectives, and motivation. The core activities were carried out using conventional learning methods, in which the teacher explained the material step by step through a lecture. The teacher provided example problems and systematically solved them, then provided exercises similar to the examples discussed. At the end of the lesson, the teacher and students compiled a summary, assigned homework, presented the material for the next meeting, and closed the lesson.

2.5. Data Collection Techniques and Instruments

The data collection technique in this study employed a test. Tests were used as a measuring tool to obtain information regarding the characteristics of students' abilities [41], [42]. Through this technique, data on students' mathematics learning outcomes were collected to determine the effect of implementing the Realistic Mathematics Education approach in the experimental class and conventional learning in the control class. Tests allow researchers to obtain quantitative data that can be analyzed objectively. Therefore, the test technique was chosen because it aligns with the research objectives, which focus on learning outcomes.

The instrument used to collect learning outcome data was a mathematics learning outcome test. This test measures students' achievement after participating in the learning process on the material studied. Measurements were conducted using a final test in the form of a daily test administered after implementing the Realistic Mathematics Education approach in the experimental class and conventional learning in the control class. Meanwhile, data for the initial test was obtained from daily test scores on previous competencies as a baseline to assess students' initial conditions. The test instrument was designed according to the learning material taught.

In addition to the learning outcome test, another instrument used was an observation sheet for teacher and student activities. This observation sheet was used to record and describe activities during the learning process. The observation data was analyzed descriptively to provide an overview of the learning implementation. The observation results were then reflected upon to assess the alignment between lesson planning and classroom implementation. This instrument served as supporting data to strengthen the research findings.

2.6. Data Analysis Techniques

The data analyzed in this study consisted of student mathematics learning outcomes. Data analysis began with descriptive statistics to obtain a general overview of the research data. Descriptive statistics included calculating the mean and standard deviation [43], [44]. The analysis then continued with inferential statistics to test for differences in learning outcomes between groups. These analysis stages were conducted systematically in accordance with the research objectives.

Descriptive analysis aimed to describe the characteristics of student learning outcome data. The data analyzed came from pre-test and post-test scores in the experimental and control classes [45], [46]. The results of this analysis were used to determine trends in the data, both at baseline and after the treatment was administered. Through descriptive analysis, differences in average learning outcomes between classes were identified. This information served as the basis for further analysis.

Inferential analysis was conducted to test the research hypotheses based on student learning outcome data. The data analyzed included pre-test and post-test scores in the experimental and control classes. Prior to hypothesis testing, prerequisite tests were conducted, including normality and homogeneity tests [47], [48]. The results of these prerequisite tests determined the type of further statistical tests used. Inferential analysis aimed to determine whether there were differences in mathematics learning outcomes between the two classes.

The normality test was used to determine whether the learning outcome data were normally distributed. The data tested included the initial and final test scores for the experimental and control classes. The normality test hypotheses consisted of a null hypothesis stating that the data were normally distributed, and an alternative hypothesis stating that the data were not normally distributed [48], [49]. Normality testing was conducted using the Chi-square test, which involved grouping the data into interval classes, constructing a frequency distribution table, and calculating the expected frequencies. Data were considered normally distributed if the calculated Chi-square value was less than or equal to the table Chi-square value. If the data were normally distributed, the analysis continued with parametric statistical tests; otherwise, nonparametric statistical tests were used.

The homogeneity test was conducted to determine whether the variance of learning outcomes between the experimental and control classes was homogeneous. This test aimed to ensure equality of data diversity between groups before conducting a test for differences in means. The null hypothesis stated that the variances of the two groups were homogeneous, while the alternative hypothesis stated that the variances of the two groups were not homogeneous. The homogeneity test was conducted using the F-test, which compares the calculated F-value with the table F-value at a significance level of 0.05 [50], [51]. Data are considered homogeneous if the calculated F value is less than or equal to the table F value. The results of the homogeneity test serve as the basis for determining the type of t-test to be used.

The mean difference test is used to determine the effect of the learning approach on students' mathematics learning outcomes. If the data are normally distributed and have homogeneous variance, a t-test is used. The null hypothesis states that there is no difference in average learning outcomes between the experimental and control classes, while the alternative hypothesis states that there is a difference in average learning outcomes between the two classes [52], [53]. The test is conducted by comparing the calculated t-value and the table t-value at a significance level of 0.05 with degrees of freedom of $n_1 + n_2 - 2$. If the calculated t-value is greater than the table t-value, the null hypothesis is rejected and the alternative hypothesis is accepted. If the data are normally distributed but the variance is not homogeneous, a t-test is used. The test is conducted by comparing the calculated t-value with a predetermined critical t-value. The test decision is based on the criteria for accepting and rejecting the hypothesis. The results of the t-test are used to determine whether there is a difference in mathematics learning outcomes between the experimental and control classes.

Nonparametric tests are used when one or both data groups are not normally distributed. The Mann-Whitney test is used to compare two independent sample groups. The test is performed by combining all data, ranking the observed values, and calculating the sum of the ranks for each group. The obtained test values are compared with the critical values in the Mann-Whitney table. The null hypothesis is accepted if the calculated test value is less than or equal to the table value. The results of this test are used to conclude whether there is a difference in mathematics learning outcomes between the experimental and control classes.

3. RESULTS AND DISCUSSION

3.1. Descriptive Analysis

From the pretest results of students in class VII 1 (control class) and VII 3 (experimental class) of Pekanbaru 9th State Junior High School, data can be obtained as in Table 2 below:

Table 2. Pretest Results Data for Experimental Class and Control Class

Class	Many Students	Average	The highest score	Lowest score
VII 3 (Experimental Class)	38	19.58	35	6
VII 1 (Control Class)	35	17.07	33	0

Table 2 shows that between class VII 3 (experimental class) and class VII 1 (control class) have different number of students, and it can also be seen that the average of class VII 3 (experimental class) is higher compared to class VII 1 (control class). Furthermore, both classes are given different treatments, for class VII 3 (experimental class) the treatment given is learning implemented using the Realistic Mathematics Education approach while for class VII 1 (control class) the treatment given is learning implemented using the conventional learning model. Then both classes are re-tested with posttest questions to determine whether there is an effect of using the Realistic Mathematics Education approach on students' mathematics learning outcomes. From the posttest results of students in class VII 3 (experimental class) and VII 1 (control class) of State Junior High School 9 Pekanbaru, data can be obtained as in Table 3 below:

Table 3. Posttest Results Data for Experimental Class and Control Class

Class	Many Students	Average	The highest score	Lowest score
VII 3 (Experimental Class)	38	56.13	91	20
VII 1 (Control Class)	35	48.46	89	12

Table 3 shows that the number of students in class VII 3 (the experimental class) and class VII 1 (the control class) differs. It can also be seen that the average posttest score for class VII 3 (the experimental class) is higher than that of class VII 1 (the control class). The following are the results of the pretest and posttest conducted by both classes:

Table 4. Pretest and Posttest Results Data

Descriptive Analysis	Pretest		Posttest	
	Experiment	Control	Experiment	Control
Average	19.58	17.07	56.13	48.46

Table 4 shows the average pretest result for class VII 3 (experimental class) is 19.58. While the average pretest score for class VII 1 (control class) is 17.07. While the average posttest score for class VII 3 (experimental class) is 56.13. While the average posttest score for class VII 1 (control class) is 48.46. The table also shows that for the experimental class before being given treatment the average score is lower than the control class, namely with a difference of 2.51 (seen from the pretest score) and after being given treatment, it is seen that for the experimental class that was given treatment during learning using the Realistic Mathematics Education approach is higher than the average score of the control class that was given treatment during learning using the conventional learning model, namely 7.67 (seen from the posttest score).

This shows that after the treatment of the experimental class using the Realistic Mathematics Education approach, the average mathematics learning outcomes increased, in other words, there was an influence on the mathematics learning outcomes of students at Pekanbaru State Junior High School 9. To see more accurately whether or not the Realistic Mathematics Education approach had an influence on the learning outcomes of the experimental and control classes, an inferential analysis was conducted.

3.2. Inferential Analysis

3.1.1. Inferential Analysis of Pretest Scores

The pretest scores were obtained from a preliminary test conducted before the research was conducted. This test was conducted before the researcher administered the treatment to the experimental and control classes. The pretest covered set operations, consisting of three descriptive questions. Following the pretest, the learning process was carried out using the Realistic Mathematics Education approach for the experimental class and conventional learning for the control class. The student pretest results are summarized in Table 5 below:

Table 5. Pretest Results Data for Experimental Class and Control Class

Class	Number of Samples (n)	Total Score ($\sum x$)	Average ($\bar{X}$)
Experiment	38	748	19.58
Control	35	604	17.07

Based on Table 5, the number of students in the experimental class is greater than the control class, with a difference of three students. It can be seen that the number of pretest scores for the experimental class is higher than the control class, with a difference of 44%. Likewise, the average pretest score for the experimental class is higher than the control class, with a difference of 2.5%. Furthermore, the pretest analysis is divided into three stages, namely:

a. Results of the Normality Test of Pretest Data for the Experimental Class and Control Class

The pretest data from the experimental and control classes were tested for normality to determine whether the data from each class was normally distributed. The results of the pretest data normality test are shown in Table 6 below:

Table 6. Results of the Normality Test for Pretest Value Data

Class	X^2 count	X^2 table	Conclusion
Experiment	8.13	11.07	Normal
Control	7.08	11.07	Normal

Based on the results of the normality test of the pretest score data in the experimental and control classes, the calculated Chi-square value was obtained which was smaller than the Chi-square table value. In the experimental class, the calculated Chi-square value of 8.13 was smaller than the Chi-square table value of 11.07. Similarly, in the control class, the calculated Chi-square value of 7.08 was also smaller than the Chi-square table value. These results indicate that the pretest score data in both classes were normally distributed. Thus, the pretest data met one of the requirements for parametric statistical analysis in the next stage.

b. Results of the Homogeneity Test of Pretest Value Data for the Experimental Class and Control Class

After conducting the data normality test, the next step is to test for homogeneity. This test is conducted to determine whether the experimental and control classes have the same variance before receiving different treatments. To determine whether the two variances are equal, a comparison is made between the Fcount and Ftable tests. Fcount is obtained by comparing the largest variance value with the smallest variance value. The calculation results can be seen in Table 7 below:

Table 7. Results of the Homogeneity Test of Pretest Value Data

Class	Varians	N	F_{count}	F_{table}	Information	Conclusion
Experiment	42.03	38	1.54	1.74	$F_{count} \leq F_{table}$	Homogen
Control	64.66	35				

Table 7 shows that F_{count} = 1,54 ≤ F_{table} = 1,74, so H_0 accepted and H_1 rejected, which means that the variance of the two classes, namely the experimental class and the control class, is homogeneous.

c. T-Test Results Pretest Value

Because the experimental and control classes were homogeneous, a test was conducted to determine the equality of the average learning outcomes of both groups. The results of the t-test for the pretest scores of the experimental and control classes can be seen in Table 8 below:

Table 8. Results of the t-test of the Pretest Value Data

Class	N	$\bar{X}$	S_{gab}	t_{count}	t_{table}	Information	Conclusion
Experiment	38	19.58	7.27	1.47	1.666	$t_{count} < t_{table}$	H_0 accepted
Control	35	17.07					

Table 8 shows that t_{count} = 1,47 < t_{table} = 1,666, so H_0 is accepted, which means there is no difference in the average mathematics learning outcomes of the experimental class with the average learning outcomes of the control class. It can be concluded that there is no difference in the average mathematics learning outcomes of students in the experimental class and the control class before the treatment (pretest).

3.1.2. Inferential Analysis of Posttest Scores

Posttest scores can be statistically analyzed using data normality tests, homogeneity of variance tests, and one-tailed mean difference tests. These posttest scores are obtained based on the final test results of student learning outcomes after treatment was administered during the learning process. The student posttest results are shown in Table 9 below:

Table 9. Posttest Results Data for Experimental Class and Control Class

Class	Number of Samples (n)	Total Score ($\sum x$)	Average ($\bar{X}$)
Experiment	38	2176	56.13
Control	35	1714	48.46

Table 9 shows that the sample size differed by three people. The posttest score for the experimental class was higher than the control class by 462, and the posttest average for the experimental class was higher than the control class by 7.67. Therefore, the posttest analysis was divided into three stages:

a. Results of the Posttest Data Normality Test for the Experimental Class and Control Class

A normality test was conducted to determine whether the posttest data from the experimental and control classes were normally distributed. The results of the normality test can be seen in Table 9 below:

Table 10. Posttest Normality Test Results

Class	X^2 count	X^2 table	Conclusion
Experiment	10.92	11.07	Normal
Control	10.58	11.07	Normal

The results of the normality test for the posttest scores in the experimental and control classes indicate that both groups of data are normally distributed. In the experimental class, the calculated Chi-Square value of 10.92 is smaller than the Chi-Square table value of 11.07. Meanwhile, in the control class, the calculated Chi-Square value of 10.58 is also smaller than the Chi-Square table value. Thus, the posttest data in both classes meet the assumption of normality. These results indicate that parametric statistical analysis can be used to test differences in learning outcomes between the experimental and control classes.

b. Results of the Homogeneity Test of Posttest Data Variance for the Experimental Class and Control Class

The homogeneity test was conducted to determine whether the experimental and control classes had homogeneous or inhomogeneous variances (diversity) after receiving different treatments. To determine whether the two variances were homogeneous or not, a comparison between the F_{count} and F_{table} tests was used. F_{count} was obtained by comparing the largest variance value with the smallest variance value. The calculation results can be seen in Table 11 below:

Table 11. Results of the Homogeneity Test of Posttest Values

Class	Varians	N	F_{count}	F_{table}	Information	Conclusion
Experiment	277.86	38	1.11	1.74	$F_{count} \leq F_{table}$	Homogen
Control	307.61	35				

Table 11 shows that the value $F_{count} = 1, 11 \leq F_{table} = 1,74$ so the conclusion is that H_0 is accepted. This means that both groups, namely the experimental class and the control class, have homogeneous variance.

c. T-Test Results Posttest Value

Because both classes, namely the experimental class and the control class, were homogeneous, a one-sided mean difference test was conducted. The results of the mean difference test can be seen in Table 12 below:

Table 12. T-Test Results of Posttest Value Data

Class	N	$\bar{X}$	S_{gab}	t_{count}	t_{table}	Information	Conclusion
Experiment	38	56.13	17.1	1.91	1.666	$t_{count} > t_{table}$	H_0 rejected
Control	35	48.46					

Table 12 shows that from the calculation results obtained with 1 the H_0 is rejected, this means that there is a difference in the average mathematics learning outcomes of the experimental class with the average learning outcomes of the control class. It can be concluded that there is an influence between the mathematics learning outcomes of students who use the Realistic Mathematics Education approach in class VII of State Junior High School 9 Pekanbaru.

The application of the Realistic Mathematics Education approach in mathematics learning provides a more meaningful learning experience for students because the material is directly linked to real-life situations [54], [55]. Learning that begins in a concrete context allows students to gradually grasp mathematical concepts, moving from informal understanding to formal concepts. This process helps students construct their own meaning from the material being studied, rather than simply memorizing formulas. Active student engagement during learning encourages deeper thinking, demonstrating the crucial role of contextual learning in improving the quality of the mathematics learning process [56], [57].

The Realistic Mathematics Education approach also encourages students to develop problem-solving skills through discussions and group work [58], [59]. During this process, students are given the opportunity to express ideas, compare solution strategies, and reflect on their thinking. Interaction between students allows for an exchange of ideas that enriches their understanding of mathematical concepts. The teacher is no longer the sole source of information but rather acts as a facilitator guiding the learning process. This learning pattern creates a more active and participatory classroom atmosphere.

From a cognitive perspective, the Realistic Mathematics Education approach helps students connect new knowledge with prior experiences. The connection between mathematical concepts and real-life contexts makes it easier for students to grasp the meaning of each procedure learned. Conceptually formed understanding tends to be more enduring than understanding acquired through mechanistic learning. This way, students are not only able to solve problems but also understand the rationale behind the steps. This supports more meaningful mathematics learning.

In addition to impacting conceptual understanding, this approach also influences students' attitudes and motivation to learn. Learning that is relevant to everyday life makes students feel that mathematics is not an abstract subject detached from reality. When students see the tangible benefits of the material being studied, their interest and confidence in learning mathematics tend to increase. A non-monotonous learning environment also creates a comfortable learning environment. This contributes to optimal student engagement throughout the learning process.

The findings of this study align with constructivism theory, which emphasizes that knowledge is actively constructed by students through interaction with the environment. Realistic Mathematics Education facilitates this knowledge construction process by presenting contextual problems as a starting point for learning [60], [61]. Through exploration and reflection, students gradually construct mathematical concepts. This reinforces the view that effective mathematics learning focuses not only on the final outcome but also on the learning process itself. Therefore, this approach is worthy of consideration as an alternative mathematics learning method in junior high schools.

Overall, learning using the Realistic Mathematics Education approach shows strong potential for improving the quality of mathematics learning. This approach is able to integrate cognitive, affective, and social aspects into the learning process. Consistent and planned implementation can help teachers create more contextual and meaningful learning. Thus, the Realistic Mathematics Education approach can be an effective learning strategy for improving students' understanding and learning outcomes in mathematics.

4. CONCLUSION

This study concludes that the implementation of the Realistic Mathematics Education approach positively contributes to improving students' mathematics learning outcomes. The findings presented in the Results and Discussion chapter confirm the expectations expressed in the Introduction, namely that learning mathematics through meaningful, real-life contexts can support conceptual understanding and improved learning performance. The alignment between the research objectives, methodological approach, and findings suggests that the Realistic Mathematics Education approach is an effective alternative to conventional mathematics instruction.

Based on the research findings, learning activities that emphasize contextual problems, active student engagement, and guided discovery enable students to construct mathematical knowledge more meaningfully. This approach not only supports cognitive development but also encourages student engagement and motivation throughout the learning process. Therefore, the implementation of Realistic Mathematics Education has strong potential to improve the quality of mathematics learning, particularly at the junior high school level.

Future research is expected to further develop these findings by applying the Realistic Mathematics Education approach to different mathematics topics, different educational levels, or longer learning periods. Furthermore, further studies could integrate this approach with learning technology or investigate its impact on other aspects of learning such as problem-solving skills, critical thinking, and students' attitudes toward mathematics. These developments are expected to broaden the application prospects and strengthen the contribution of Realistic Mathematics Education to mathematics education research and practice.

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